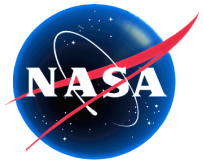

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Atmospheric Infrared Sounder (AIRS) Project Report

Thomas S. Pagano
AIRS Project Manager
Jet Propulsion Laboratory

October 9, 2007

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Agenda

- Instrument and Spacecraft Status
- AIRS Products and Usage
- ROSES Selections
- Aqua/AIRS Sr. Review Results
- AIRS Product Validation Status
- 2007 NASA Awards for AIRS
- Summary

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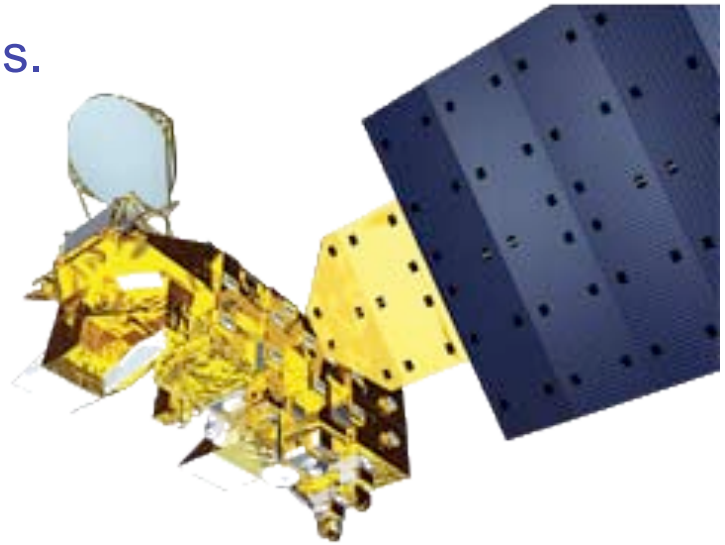
Instrument and Spacecraft Status

- Instruments operating well. No problems.
  - High Calibration Accuracy
  - Extremely Stability
  - Performance
    Continues to be Excellent
  - Slight AIRS detector and cooler degradation with time being monitored
  - An AIRS/AMSU-A anomaly resolution guide is in preparation



- Spacecraft operating well
  - Dual Thruster Module #2 (DTM-2) anomaly
    - Loss of redundant heater on one of thrusters. Using backup.
  - Considering Relocation of Aura closer to Aqua
  - Aura STM. Discussed Aura re-location closer to Aqua (~8 vs. 15 min); would be achieved by atmospheric drag so would take about 10 mos. We originally used the 15 min. separation for downlink reasons. But now have additional antennae in Norway and Alaska
  - Conservative estimate of hydrazine supply says fuel will last at least until 2015

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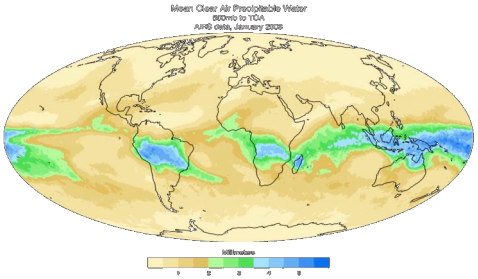
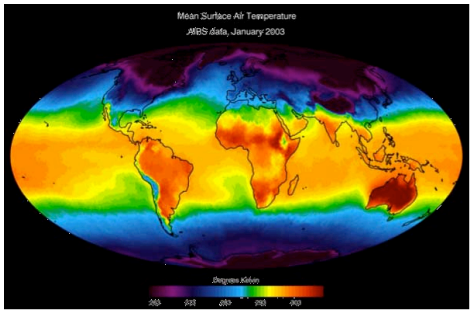
AIRS Earth Science Products

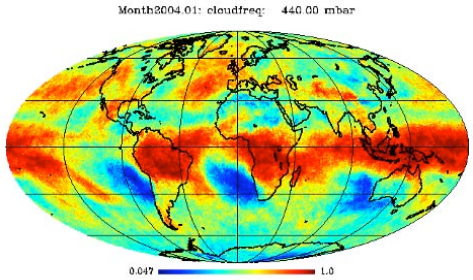
Atmospheric Temperature



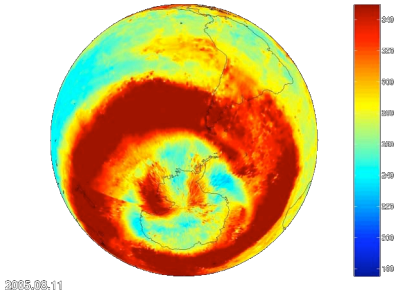
Atmospheric Water Vapor



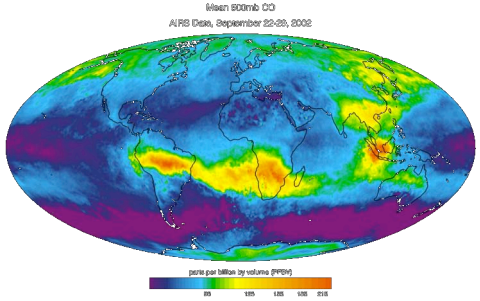
Cloud Properties



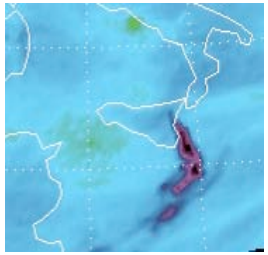
Ozone



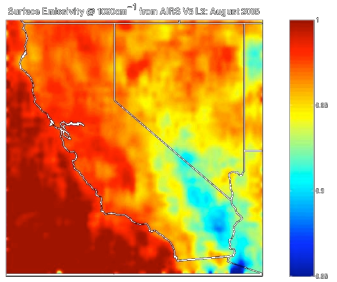
CO



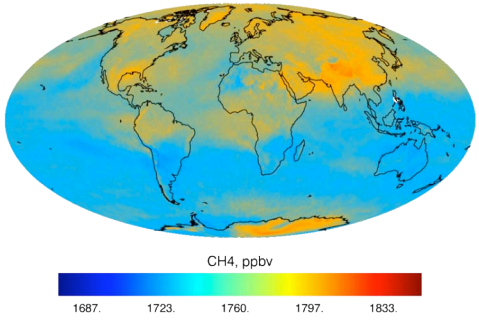
SO2



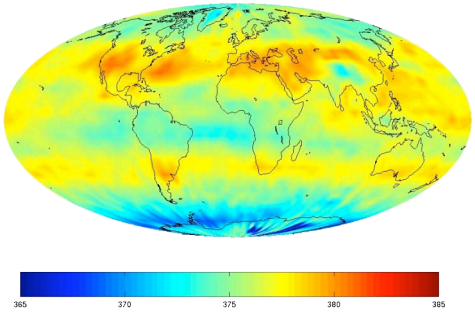
Surface Temperature Emissivity



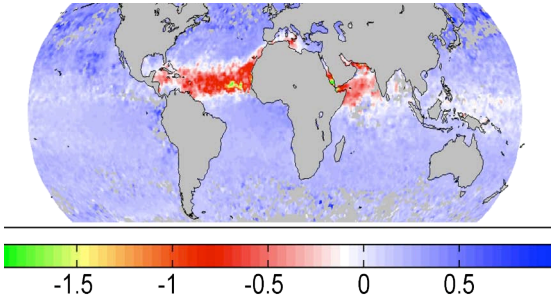
Methane

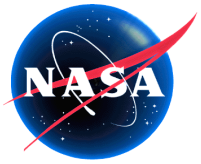


CO2



Dust





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AIRS Improves Weather Forecasting and Climate Modeling

- **Improved weather prediction**
  - 11 Hours on the 6 Day Forecast (6 hours Operational Today)
  - GCM Process Validation (H2O, Clouds, Temperature)
  - Regional Imagery in Near Real Time (SPoRT)
    - NRT Processing at the GES/DIS
    - Direct Broadcast Receiving Stations
- **Improved climate prediction**
  - AIRS Measures Key Earth Science gases: H_2O, CO_2, CH_4, CO, O_3
  - Improves Global Transport Studies
  - Helps Determine the role of water vapor and clouds on radiation balance
  - AIRS Data used to validate and improve parameterization for climate models

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ROSES Results
AIRS in Abstract (1 of 3)

- **Robert Adler/NASA Goddard Space Flight Center**
  "Multi-Instrument, Multi-Satellite Precipitation Analysis Using Aqua AMSR and AIRS Information"
- **Hartmut Aumann/Jet Propulsion Laboratory**
  "In-Flight Radiometric Validation of AIRS, IASI and CRIS Science Data Records for Climate Analysis"
- **Bryan Baum/Space Science and Engineering Center**
  "Refinement of Ice Cloud Bulk Optical Models: From Microphysical Measurements to Global Retrievals Using Multiple Satellite Instruments"
- **William Blackwell/MIT Lincoln Laboratory**
  "Algorithm Refinement and Calibration/Validation Activities for AMSU/ATMS"
- **Mian Chin/NASA Goddard Space Flight Center**
  "A Global Model Study of Emissions and Long-Range Transport of Aerosols and Trace Gases Using Terra and Aqua Satellite Data"
- **Stephen Eckermann/Naval Research Laboratory**
  "Three-Dimensional Characterization of Atmospheric Gravity Waves Using Thermal Radiance Imagery Acquired from Aqua"
- **Qiang Fu/University of Washington**
  "Understanding Tropical Stratosphere-Troposphere Exchange through Analyses of EOS Satellite Data and Global Climate Modeling"
- **Mitchell Goldberg/NOAA/NESDIS/ORA**
  "AIRS Algorithm Maintenance, Improvements, Validation, Monitoring and Generation of Near Real-Time Products"

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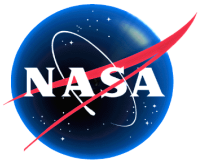
ROSES Results
AIRS in Abstract (2 of 3)

- **Laura Hinkelman/National Institute of Aerospace**
  "Extending the Cloud and Radiation Climate Record: Climate Calibration of the ISCCP/SRB Narrowband Imagers from 1983 to 2005"
- **Henry Revercomb/University of Wisconsin-Madison**
  "Assessment and Optimization of IR Radiance Measurements for Climate, Assimilation, and Remote Sensing Applications, using high resolution spectra (S-HIS, AIRS, CrIS, and IASI) as transfer standards for other IR observations (MODIS, VIIRS, CERES, GOES)"
- **Richard Rood/University of Michigan**
  "Process-Based and Object-Based Investigation of Bias in the Simulations of the Physical Climate"
- **Lawrence Strow/University of Maryland Baltimore County**
  "A Hyperspectral Infrared Radiance Climate Record using AIRS, IASI and CrIS"
- **Si-Chee Tsay/NASA**
  "Synergy of Satellite/Surface Observations and Light-Scattering/Radiative-Transfer Modeling for Aerosol Research"
- **Matthew Watson/Michigan Technological University**
  "Using ASTER, MODIS and AIRS to Estimate Global Gmissions of Volcanogenic SO2"
- **Eric Wilcox/NASA Goddard Space Flight Center**
  "Understanding Constraints on Aerosol-Cloud Interactions in A-Train Observations"
- **Liguang Wu/University of Maryland Baltimore County**
  "Study of the Influence of the Saharan Air Layer on Tropical Cyclone Intensity Using Data from Aqua Multi-Sensors and other A-Train Satellites"



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ROSES Results
AIRS in Abstract (3 of 3)

- **HL Huang/University of Wisconsin-Madison**
  "International MODIS/AIRS Processing Package (IMAPP) Maintenance, Support and Multisensor Product Development for Terra and Aqua Direct Broadcast Users"
- **Paul Menzel/ University of Wisconsin**
  "Development of a Decadal Cloud Climatology from NOAA polar orbiting (AVHRR and HIRS) through EOS (MODIS and AIRS) to NPOESS (VIIRS and CrIS)"
- **Joel Susskind/NASA Goddard Space Flight Center**
  "Development, Validation, and Scientific Evaluation of a Multi-year Sounder Based Climate Data Set Using Products Derived from AIRS/AMSU and TOVS Observations"

19 Selections out of 97 Involve use of AIRS Data

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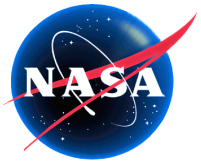
Senior Review: AIRS Ranked High for Operational Weather Forecasting

CORE MISSION REVIEW PANEL

	CoMRP Ranking	NOAA	USGS	Navy	Other DOD
Aqua	**Very High**	Very High	Very High	Very High	Very High
MODIS	*Very High*	*Very High*	*Very High*	*Very High*	*Very High*
AIRS	*Very High*	*Very High*	*NA*	*Very High*	*Very High*
AMSR-E	*Very High*	*High*	*NA*	*Very High*	*Very High*
CERES	*NA*	*NA*	*NA*	*NA*	*NA*
Terra	**Very High**	Very High	Very High	Very High	Very High

AIRS was rated as very high for the aid it provides to the weather forecasting. The *AIRS Atmospheric Minor Constituents* products, however, were not rated high by any panelists.



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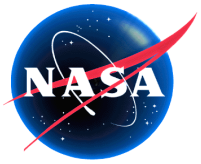
Senior Review Panel Expressed Concern over Validation Status and Trace Gas Products

- **NASA EARTH SCIENCE SENIOR REVIEW PANEL**

- Current data products are in various stages of validation, but the AIRS products, being new and complex in nature, are lagging behind the development and dissemination of other Aqua measurements. The AIRS core data products ought to be brought to maturity prior to the end of the Prime mission in September 2008.
- The proposed enhanced mission data products were deemed to be better suited for incorporation into ongoing core mission efforts or for competition via the NASA R&A program.
- There are some obvious redundancies between the new AIRS products and MOPITT (CO) and TES (CO, O3) with no clear plan for producing either a single combined product or at least two, rationalized, non-conflicting data products. While the AIRS measurements have different vertical averaging kernels, there is so much overlap that inconsistencies will become apparent once these products are used by the community.
- AIRS algorithms and products are "newer" than the products from other Aqua instruments. Many products are currently experimental (beta, provisional, or validation-1) with uncertain overall accuracy and uncertain scientific usefulness. All of the Aqua data products, and those of AIRS in particular, need to be reviewed in terms of data quality and scientific utility at the end of Prime mission in FY2008.



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AIRS Products and Validation Status

AIRS Product	Uncertainty Estimate (Version 5)	Val Status (Version 5)	Source
Radiances			
AIRS IR Radiance	<0.2%	Stage 3	Project
AIRS VIS/NIR Radiance	15-20%	Stage 1	Project
AMSU Radiance	1-3 K	Stage 3	Project
HSB Radiance	1-3 K	Stage 3	Project
Core Products			
Cloud Cleared IR Radiance	1.0 K	Stage 2	Project
Sea Surface Temperature	1.0 K	Stage 2	Project
Land Surface Temperature	2-3 K	Stage 1	Project
Temperature Profile	1 K / km	Stage 2	Project
Water Vapor Profile	15% / 2km	Stage 2	Project
Total Precipitable Water	5%	Stage 2	Project
Fractional Cloud Cover	20%	Stage 2	Project
Cloud Top Height	1 km	Stage 2	Project
Cloud Top Temperature	2.0 K	Stage 2	Project
Neccesary Products*			
Total Ozone Column	5%	Stage 2	Project
Ozone Profile	20%	Stage 2	Project
IR Dust**	0.5 K	Stage 1	Project
Research Products			
Carbon Monoxide	15%	Stage 2	NOAA/UMBC
Methane	2%	Stage 1	NOAA
Carbon Dioxide**	1-2 ppm	Stage 1	NASA/NOAA
OLR	5 W/m2	Stage 1	GSFC
HNO3**	0.2 DU	Stage 1	NOAA/UMBC
Sulfur Dioxide**	1 DU	Stage 1	NOAA/UMBC

*Necessary Products are required to retrieve accurate temperature profiles (1K/km) in all condition
**Product not yet available in AIRS Level 2 Files. Products will be available in Version 6

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Version 6 Priorities

- Level 1C Climate Product (New)
  - Resampled to constant spectral grid to remove very small instrument artifacts with age
- Level 2
  - Retrieve Surface Emissivity
  - Improve Boundary Layer Sensitivity
  - Yield Improvement in Critical Areas
  - Initialization State and Error Estimation
  - RTA Improvement
  - Cloud Retrieval Improvement
  - Retrieve Mid Tropospheric CO2
- Level 3
  - Reduce Sampling Bias Effects
- Validation Priorities
  - Validate all Version 5 Products

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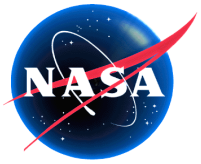
2007 NASA Honor Awards at JPL
June 21, 2007

NASA Exceptional Scientific Achievement Medal Awarded to
AIRS Team Leader Moustafa T. Chahine

NASA Group Achievement Award
AIRS Science Team
Accepted by AIRS Project Scientist George Aumann



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NASA Public Service Group Achievement Awarded to AIRS Science Team

"For development and verification of the AIRS Level 2 Product Generation Algorithm which accurately produces global profiles of temperature, water vapor and trace gases daily"

Bob	Atlas
George	Aumann
Christopher	Barnet
Roberto	Calhieros
Moustafa	Chahine
Alan	Chedin
Catherine	Gautier
Mitch	Goldberg
Eugenia	Kalnay
Robert	Knuteson
John	LeMarshall
Stephen	Lord

Wallace	McMillan
Larry	McMillin
Anthony	McNally
Hank	Revercomb
Phillip	Rosenkranz
Roger	Saunders
Bill	Smith
David	Staelin
Larrabee	Strow
Joel	Susskind
Dave	Tobin

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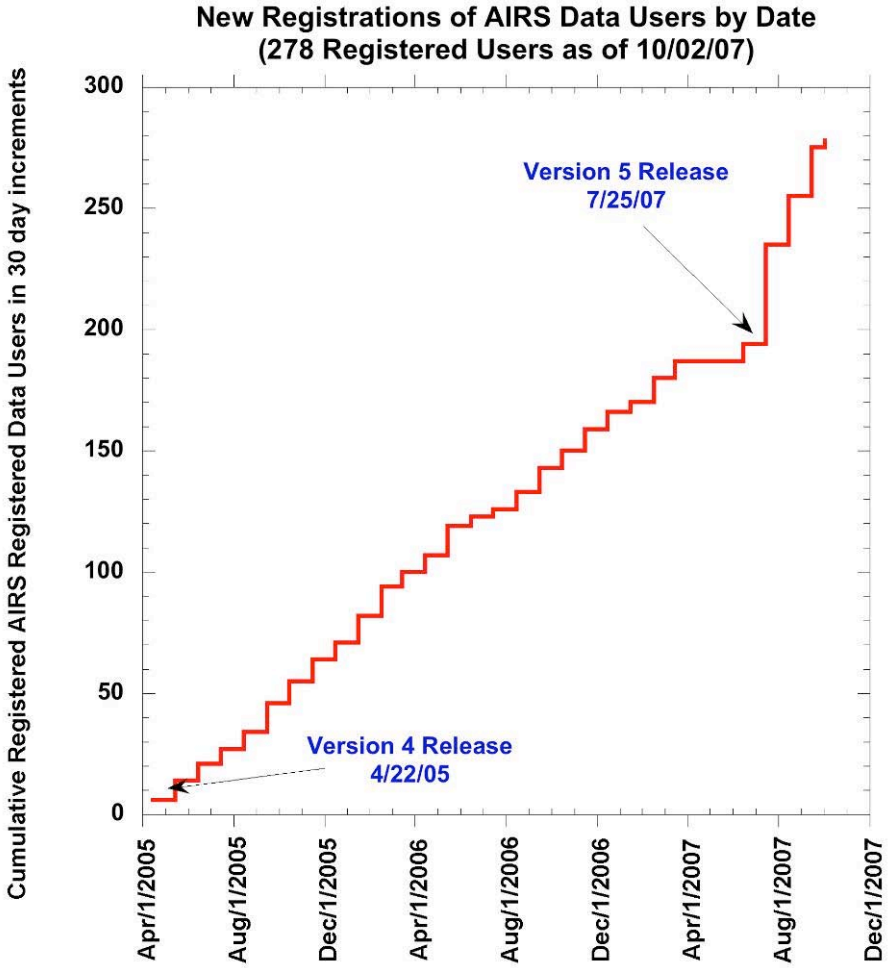
AIRS Registered Users Continue to Grow



Ed. Olsen

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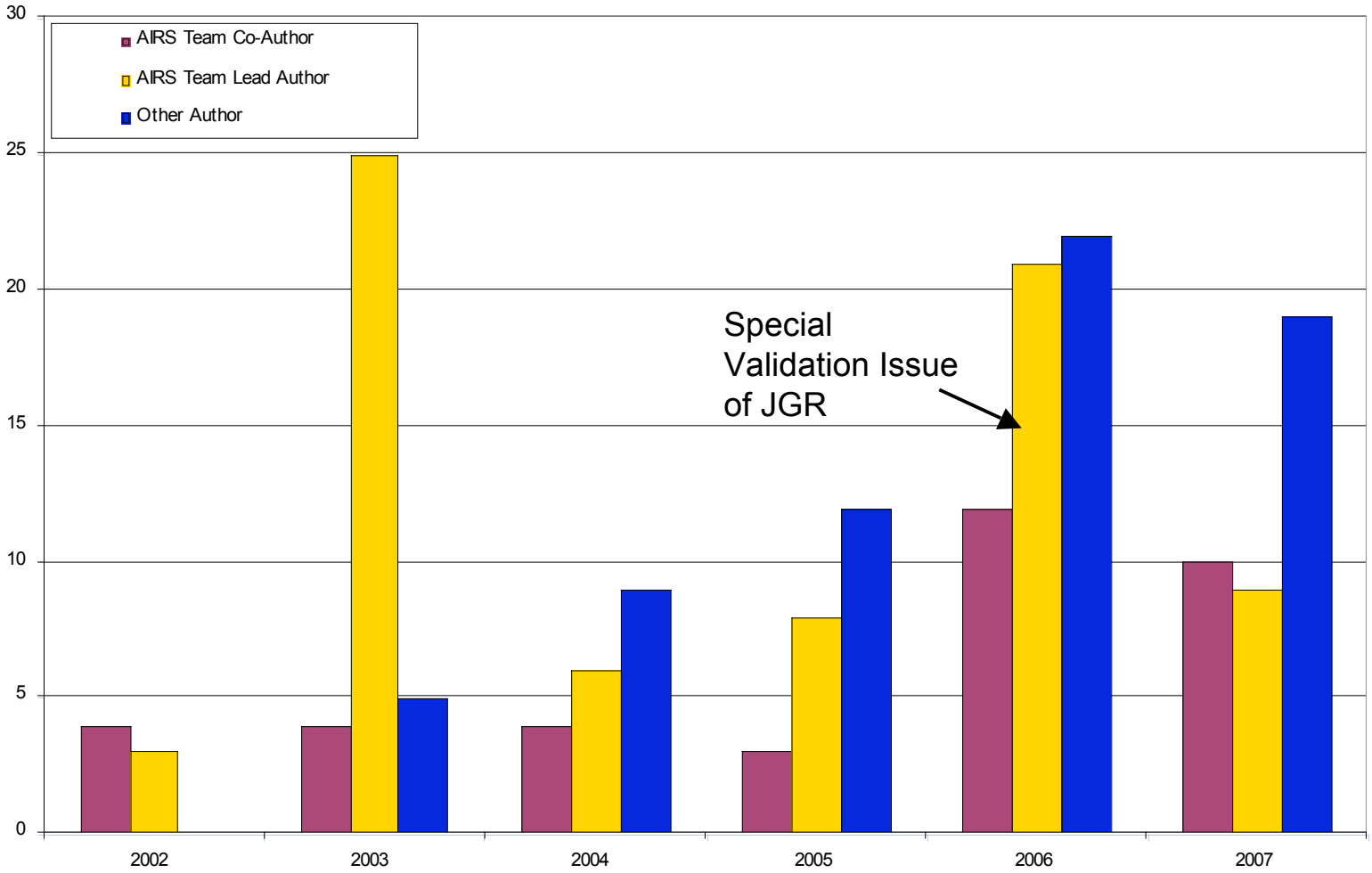
Number of AIRS Peer Reviewed Publications as of 10/08/2007



Summary

- AIRS Instrument and Aqua Spacecraft Continue to Operate with Normal Parameters
- Version 5 Released to the Public: 07/25/07
  - Verification Report and User Documentation Complete
- Senior Review Complete
  - Full Baseline Approved. No enhancements funded.
  - Need All Core Products Validated by end of FY '08
- Registered Users grew rapidly with V5 release.
- Version 6 Objectives In Place.
  - Plan Details to be Covered Thursday
- Project running smoothly; science papers and accomplishments from AIRS continue